A dangerous idea: that Koala densities can be low without the populations being in danger

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ABSTRACT

The great public appeal of the Koala *Phascolarctos cinereus* gives it political power. Its appeal has been used successfully to publicise its vulnerability to the clearing of its habitat. The result is that the protected bushland also preserves habitat of numerous species that lack the Koala's political influence. However, any research that indicates that the Koala is less vulnerable than is generally believed may lessen the species' political power. The authors of such research may feel like traitors to the cause of ecological conservation.

Nevertheless, several features of Koala ecology must be considered. Firstly, their sustainable density for any habitat is unknown. The fact that they were not discovered by European colonists during the first 10 years of settlement indicates that the original population density was very low near Sydney. Secondly, our observations of a low-density population at Campbelltown show that, in the absence of chlamydiosis, longevity and reproductive success are approaching maximal, as are dispersal rates. We believe that these factors have led to a local increase in numbers and distribution. Thirdly, it appears that the southern regions of NSW have a scattered distribution of very low-density populations. Distributions of these populations and the presence of linking vegetation may be more important to our notions of Koala survival than changes in actual numbers of animals.

Key words: Koala, *Phascolarctos cinereus,* translocation, Campbelltown, Tarlo River National Park, distribution, low-density.

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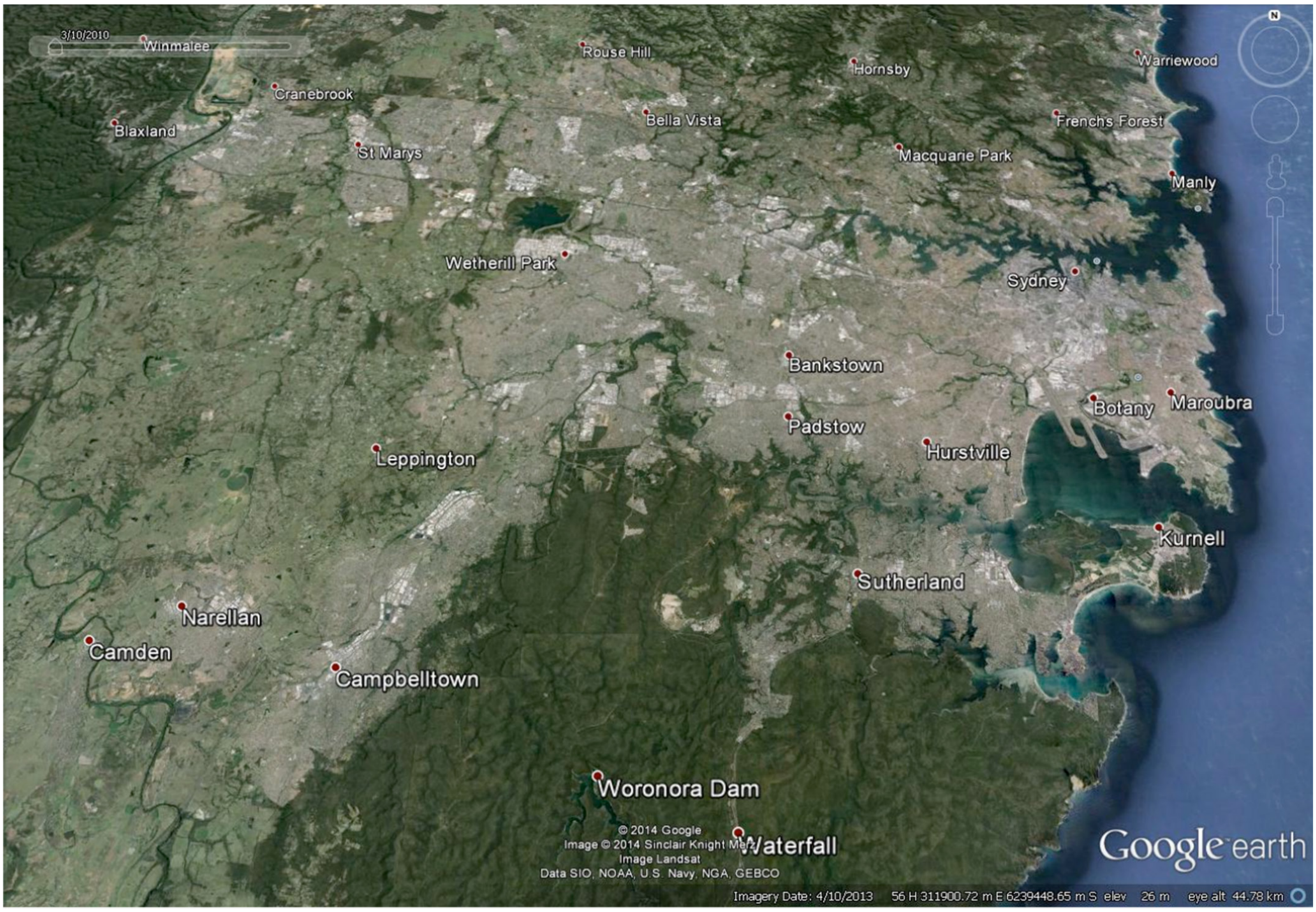
Introduction

Political campaigns are often run to protect Koalas *Phascolarctos cinereus* and their habitat. Perhaps the most significant was conducted before the 1996 Queensland State elections to change plans for a freeway that would have affected Koala habitat (Courier Mail 2009; Krosch 2010). In NSW, a campaign beginning in 1987 to protect a population of Koalas near Campbelltown, 45 km southwest of Sydney CBD (Fig. 1), and prevent the loss of bushland (Dobson 1990; Sheppard 1990), eventually led to the declaration of Dharawal National Park in 2012 (OEH 2014a). The same population was also used in a campaign to prevent the construction of Sydney's second airport at Holsworthy Firing Range (Frew 1997).

The power and appeal of the Koala come largely from its cuteness; but its perceived vulnerability is also a factor (Phillips 1990). Many populations are being affected by the loss and modification of habitat, high mortality rates due to motor vehicle accidents, dog attacks and disease, and in some instances as the result of increased frequency of drought or a combination thereof (Gordon et al. 1988; Lunney *et al.* 2014; Melzer *et al.* 2000). If, however, research shows Koalas to be less vulnerable than is generally supposed, then the public may be less inclined to protest about threats to their safety and habitat and donate funds for research and protection. For example, Koalas receive less official protection in Victoria than in NSW, Queensland and the ACT, where the species is perceived to be under greater threat. Thus, by learning more about the Koala and circumstances that permit them to maintain a stable or increasing population, we may disadvantage both the Koala and the many species for which it is an ecological flagship (NKCS 2009). For example, the declaration of the Dharawal National Park described above (OEH 2014a and b), benefited several vulnerable but little known species such as the Broad-headed Snake *Hoplocephalus bungaroides.*

A major impediment to assessing the vulnerability of Koala populations is the dilemma of not knowing the original density of any Koala population prior to European settlement. In this paper we use data collected from a twenty four-year, community-assisted survey and radio-telemetry study to assess the status of a low-density population of Koalas at Campbelltown on the southern outskirts of the Sydney basin. We also use data obtained from a translocation study to examine whether Koala populations can function at very low densities.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Botany
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Leppington
Hurstville
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Figure 1. Location of study area (Campbelltown) in the Sydney Basin.

Original and sustainable densities

There is strong evidence that at the time of European settlement, Koalas were at very low densities in the Greater Sydney area. It was not till 10 years after settlement that the first individual was sighted by the European settlers, near Bargo on the south-western edge of the Sydney basin. Furthermore, the first physical signs (feet) were not collected for another four years and the first complete animal was not captured until a year later (Lunney *et al.* 2010a).

The reason for this apparently low density of Koalas is likely to be hunting pressure from humans (Lunney, D. quoted in Recher *et al.* 1993) and dingoes *Canis Dingo*. Kohen (1995) has calculated the effect of 2000 indigenous Australian hunters on the population of grey kangaroos in the Sydney basin and predicted that if each hunter killed two kangaroos per year then the population would be driven to local extinction. Likewise for Koalas, relatively few animals would need to be killed per hunter to keep the density low.

Indigenous Australians apparently prized Koalas at the time, because the feet mentioned above cost the explorer Barralier two spears and a tomahawk (Barralier 1975, cited in Lunney *et al.* 2010a). Other evidence of hunting is that provided in Archer (2002) and by Recher *et al.* (1993).The former is a photograph from the Thomas Dick Collection showing an indigenous hunter carrying several dead animals including a koala. Recher *et al.* (1993) reported Koala remains in middens north of Sydney at Upper Mangrove Creek while Martin and Handasyde (1999) quoted J. Bulmer's description of hunting methods used by indigenous Australians in Gippsland. Bulmer reported that the hunters were prepared to face considerable risks and spend a lot of time in climbing in order to capture a koala.

It seems to us that had Koalas been present in the Sydney basin, even at densities as low as 0.01/ha, then the extensive clearing of vegetation in the first 10 years of settlement would have revealed them. A painting by John Lewin in 1806 shows a landscape of tree stumps at Castle Hill (Mitchell Library reproduced in Benson and Howell 1990). Coincidently, Lewin also sketched a Koala with back young in 1803 (Mitchell Library reproduced in Moyal 1986), probably the first live specimens brought into Sydney.

Although Koalas were possibly detected by the tree-clearers but not referred to local naturalists, it is difficult to believe that such an unusual animal would not be reported in an era when the influence of Sir Joseph Banks was still significant, and included sponsoring George Caley who used Aboriginal collectors to collect novel specimens (Moyal 1986). Koalas, therefore, were either not living in the Sydney basin or were at such a low density that they were virtually undetectable. The fact that they are found today at several sites on the edge of the basin (Ward and Close 2004; Lunney *et al.* 2010b; Recher 2010) makes the latter suggestion seem more likely than the former.

Given that Koalas have co-existed with indigenous people and dingoes for several thousand years (Kohen 1995; Martin and Handasyde 1999), Koalas must have existed across their range in a sustainable density at the time of European settlement. However, that density is unknown. A sustainable density, that is, one that can maintain a population over many thousands of years, may be considerably lower than current densities estimated for some other populations. Martin and Handasyde (1999) and Melzer *et al.* (2000) have reviewed some recorded densities which vary from 0.006/ha in the South East Forests of NSW (Jurskis and Potter 1997) to >8/ha in north-eastern Victoria (Downes quoted by Martin and Handasyde 1999). However, densities can change over time (Sullivan *et al.* 2004) under the effect of changes in various limiting factors such as fire, drought, soil fertility and disease (Melzer *et al.* 2000). If all populations were viable at densities even half as low as 0.006/ha there would be ramifications for management of Koalas where declines in numbers are generally the cause of great concern. For example, McAlpine *et al.* (submitted 2014) reported that a population at Iluka on the northern coast of NSW had reappeared after initially being feared extinct. Either Koalas had immigrated from other populations or the density had become too low to detect.

Some declines may be, in part, due to excessively high population densities. As an example, the population increase that followed the decline of hunting pressure from indigenous people in the latter half of the 19th century coincided with widespread sickness among Koalas (Melzer *et al.* 2000). It is likely that this sickness was caused by chlamydia infections and dissemination of these sexually transmitted diseases may have been influenced by the increased density of Koalas (reviewed by Martin and Handasyde 1999; Gordon and Hrdina 2005). Another example of the impact of high density populations is the damage to vegetation from over-browsing that is occurring on Kangaroo Island and Cape Otway (Duka and Masters 2005, Menkhorst 2008).

A low-density population

A low-density population is not necessarily more vulnerable than one of mid or high-density. An example of a low-density population of Koalas that appears to be healthy and increasing in number is found on the south western edge of the Sydney basin near Campbelltown, NSW (Figure 1). The population extends beside the Georges River from Macquarie Fields to Appin and east across the Holsworthy Firing Range and Woronora Catchment to Heathcote National Park (Figure 2; Ward and Close 2004; Lee *et al.* 2010). The Campbelltown population was virtually unknown prior to 1986 although numbers had been apparently sufficient for the Koalas to be shot for their skins in the early years of the twentieth century (Fowler 2004; Lunney *et al.* 2010a). Since 1986 there have been numerous sightings (Ward and Close 1998; Ward 2002; Ward and Close 2004; Lunney *et al.* 2010b). The current number of sightings on the database at the University of Western Sydney, Campbelltown, now exceeds 3500. Many of the records from the bushland/suburban interface, however, are multiple sightings of female Koalas in established home-ranges. Females occupy most of the suitable habitat in the region and local residents often see them (unpublished data). More than 140 Koalas in the area have been ear-tagged during the 24 year study. Some of these tagged animals have dispersed widely and have been seen at Douglas Park (20 km SW), Alfords Point (17 km NE), Heathcote National Park (15 km E) and Menai (15 km ENE) (Ward and Close 1998, 2004; Lunney et al; 2010b and unpublished).

While it is possible that Koala numbers at Campbelltown have always been stable and the paucity of sightings before 1986 was due to the lower number of observers and the lack of a reporting system, we believe that the increase in number and distribution of sightings reflects an increasing and spreading population. Evidence that the Campbelltown population is healthy and expanding includes findings from a 20 year radio-telemetry study that shows that females live long lives and produce many offspring. In this study, 9 of 11 long-term, radio-collared females lived for 10+ years, and most for 13-14 years (unpublished data). The remaining two females were 8 years old or older: one died of an unknown cause, while contact with the other was lost after 8 years. Unverified sightings indicated that the latter was still alive at the age of 16 years.

All the other radio-collared females died of natural causes and all but one weaned young almost every year. The exception weaned two young in nine years but died with a chronic infection in the jaw. Several of the female offspring of the radio-tracked animals established home-ranges adjacent to their mothers' home-range, while others moved several kilometres. Home-ranges of females ranged from 10-30 ha (Ward 2002 and unpublished data) and several home-ranges included minor roads and were adjacent to houses with dogs. The radio-collared females, therefore, were each reproducing at a rapid rate of almost one per year and raising their young successfully to weaning. Significantly, no clinical signs of chlamydiosis were detected in any of the Campbelltown animals. The longevity and high reproductive rate of these animals may result from the relatively large size of their home-ranges. Greater sizes would allow more choice in suitable trees for food and shelter and would increase the chances of the area including water resources and topographic protection. As an example of the latter, Figure 3 shows a radio-collared koala sheltering in a cave on a hot day. Such behaviour may also provide protection from fire.

Phillips and Callaghan (2011) estimated that the Campbelltown Koalas have a "low" (arbitrarily defined

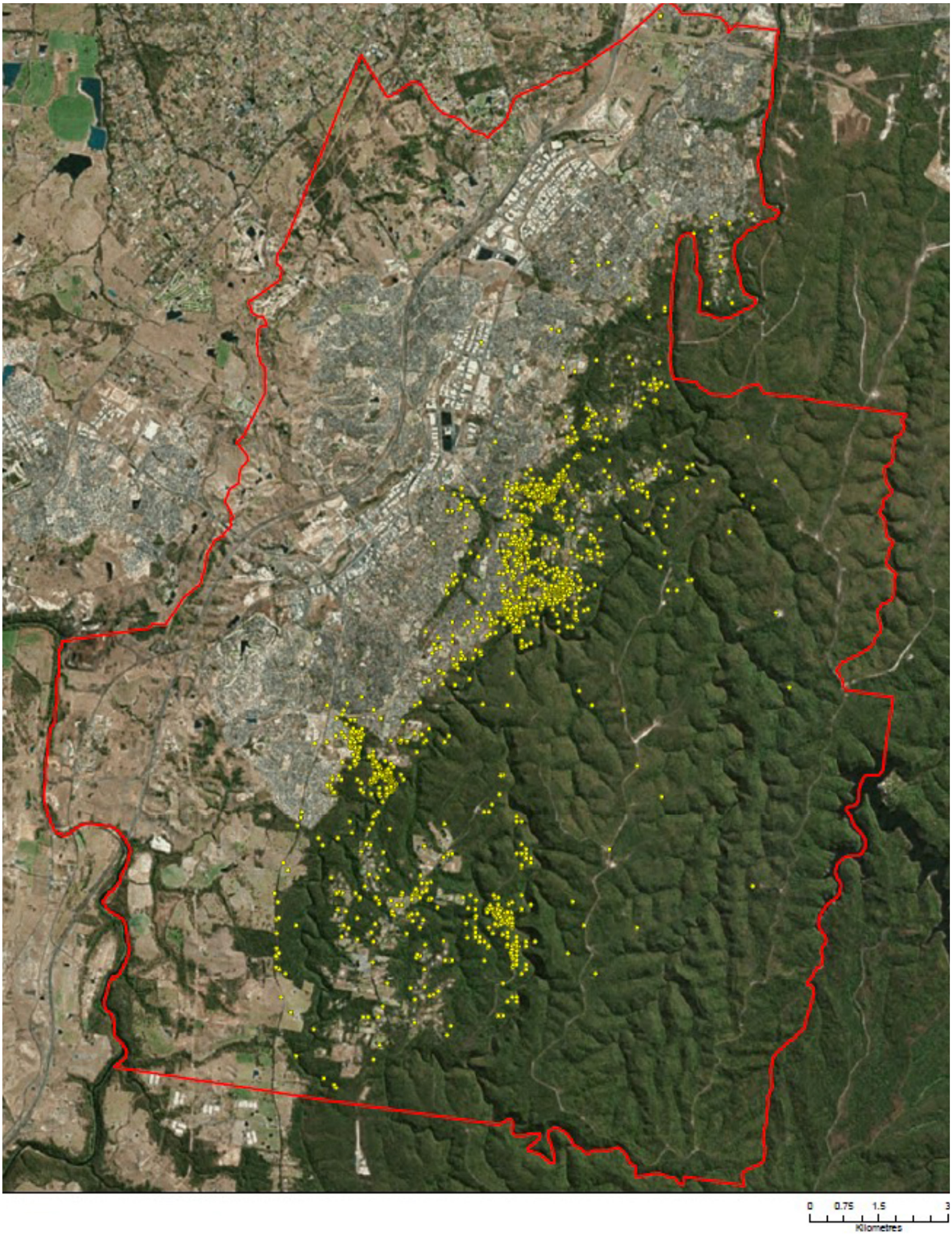

Figure 2. Sightings of koalas in the Campbelltown area. Yellow circles represent sightings of koalas. The red line marks the Campbelltown Local Government Area. The map was prepared by Eco Logical Australia for the Campbelltown City Council's Draft Campbelltown koala plan of management 2013.

as <0.1/ha) population density. In comparison, Melzer *et al.* (2000) define a "moderate" density as1-3/ha and "high" as 4-8/ha. Provided there is no significant loss of habitat, change in climate or exposure to chlamydia, we predict that the Campbelltown population has recovered from a very low density in the last 30 years and will continue to increase in number and distribution until all suitable female home-ranges are occupied. This prediction of a spreading distribution is consistent with the fact that between August 2013 and August 2014 there have been two road kills, one a female with a large young, and, most recently, a sighting of a female with back-young, at Glenfield, all 4 km north of the previous most northerly sightings of a breeding female.

Very low density populations

An important question is whether Koalas can function sustainably at significantly lower population densities than at Campbelltown. This question is significant because if Koalas can exist at such low densities, there may be many undetected populations south of Sydney, and the status of Koalas in NSW may be healthier than is generally supposed. Melzer and Lamb (1994), (cited in Martin and Handasyde 1999) reported Koala densities of 0.005/ha in central Queensland while Jurskis and Potter (1997) estimated densities near Eden in south eastern NSW of 0.006/ha and Sullivan *et al.* (2004) found densities of 0.0007/ha and 2.5/ha in different habitats of south western Queensland.

These low-density populations may not be sustainable. Perhaps the central Queensland and Eden populations are on their way to extinction. Gordon *et al.* (2006) found a decline in the area of occupancy of koalas in Queensland of 31% while Lunney *et al.* (2014) have shown that the distribution and abundance of koalas in southern NSW are declining in association with increased habitat damage, increased temperatures, reduced rainfall and housing development.

Evidence that koalas have special qualities for survival at low-density emerged from our unpublished study of a translocation trial (2006-2013) that involved moving young adult Koalas 100 km south from Campbelltown to Tarlo River National Park. Koalas had not been reported from the park since the 1970s. Within 6 weeks of translocation of the first pair, however, a local male was discovered in a tree adjacent to the translocated female. Only one other sighting of a local animal was made during the remaining seven years of the project, despite the considerable time spent in the park by the radio-tracking

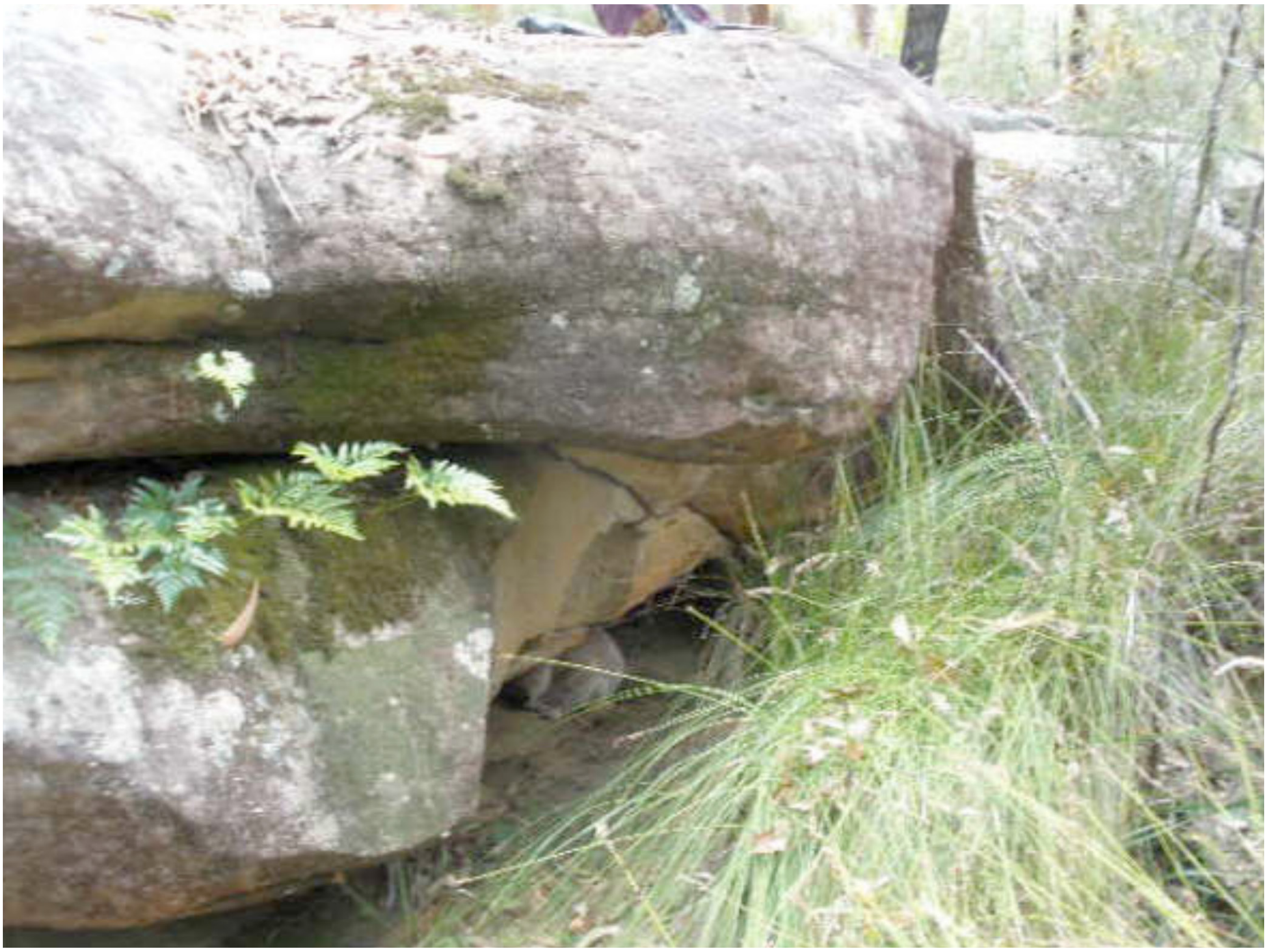

Figure 3. Radio-collared male koala sheltering in a small cave on a hot day. Photo by Kieran Griffin.

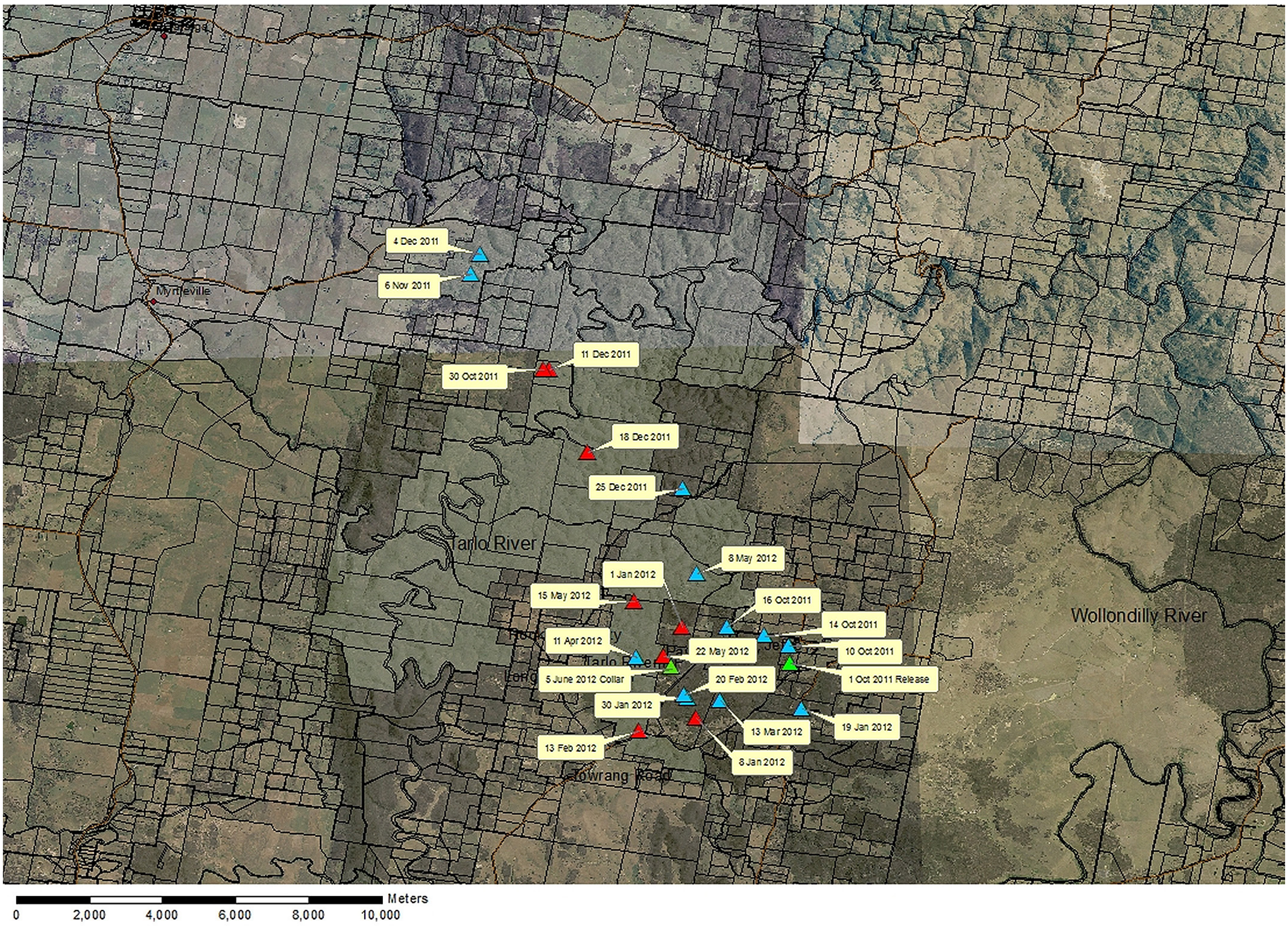

Figure 4. Movements of a young male koala after translocation from Campbelltown to Tarlo River National Park. Green triangles are the first and last locations; blue triangles are physically tracked locations; red triangles are remotely tracked (Argos)

team. Nevertheless, DNA analysis of a joey, born to one of the translocated females, indicated that the father was local (T.Lee and D. Phalen, unpublished data).

During this study, two young, translocated males independently moved large distances across rugged terrain. One moved 12 km north in 37 days then returned along a similar path in 27 days, patrolled an area of 800 ha for 5 months and was within 1 km of a translocated female when it lost its collar. It had moved a minimum of 45 km in 9 months (Figure 4). The translocated females moved only a few km before setting up home-ranges of 50-100 ha (unpublished data). Our extensive, failed attempts to locate the pellets or presence of two translocated female koalas with 100 ha home-ranges, whose radio-collars had been lost or damaged, demonstrated how difficult it is to locate koalas at low densities.

It appears, therefore, that Koalas can find each other despite very low population densities, large home-ranges, and being in unfamiliar country. Low-density populations, such as that at Tarlo River NP, may exist more widely south of Sydney than is generally suspected. Directly south of Campbelltown, there is continuous bushland through the protected catchments of the Cataract, Cordeaux, Avon and Nepean Dams and then Moreton National Park, Budawang NP, Deua NP, Wadbilliga NP and then the South East Forests NP, as well as several smaller State Forests and National Parks. Although koalas have been sighted in the dam catchments (Tilley and Uebel 1990, Lunney et al 2010b), in the South East Forests (Jurskis and Potter 1997; Lunney *et al.* 2014), and in all the National Parks listed above (DECC 2008), few reports of Koalas were recorded for those National Parks and forests during state-wide surveys (Reed *et al.* 1990; Lunney *et al.* 2009; Lunney *et al.* 2014), However, we predict that functional populations of very low densities exist in all these forests. Phillips and Callaghan (2011) estimated, in fact, that the density of Koalas in the South East Forests was greater than that in Campbelltown, although they classified both populations as "low". If our predictions are correct, and the densities are of the order of 0.01/ha, then these extensive forests would support a large number of Koalas. The widespread distribution would protect against local extinctions and the Koalas' ability to disperse would facilitate recolonisation. In short, provided sufficient bushland remained, Koalas would be well equipped to survive disadvantageous environmental changes: home-ranges would become larger and overall densities would become lower but the population would still function until the habitat contained too few trees of sufficient dietary and shelter quality for individuals to be able to maintain contact with each other, or until the habitat became too fragmented to permit successful dispersal. The ability of koalas to function at very low densities presents challenges for impact assessment of development proposals in these low-density populations because it is difficult to ascertain if Koalas are present, the value of the habitat to them, and the impact of loss of habitat.

Conclusion

We contend that Koalas in established home-ranges are resilient to some peri-urban stressors, such as dogs and cars, and are equipped to survive at low densities which may have been the norm prior to European settlement. We predict that Koalas south of Sydney are widely scattered in low density but functional populations and that some or all of these populations will increase in number, as seen in Campbelltown.

If these good news predictions are correct then the status of Koalas south of Sydney is less vulnerable than is currently recognised and the official status of the species may eventually have to be down-graded. Down-grading would then reduce the Koalas' political power. Community assistance is required to test our predictions via permanent requests to record sightings, and regular surveys, such as those described by Lunney *et al.* (2010b and 2014) and the successful on-line survey conducted recently by the National Parks Association (Cleary 2014; Woodburn 2014).

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